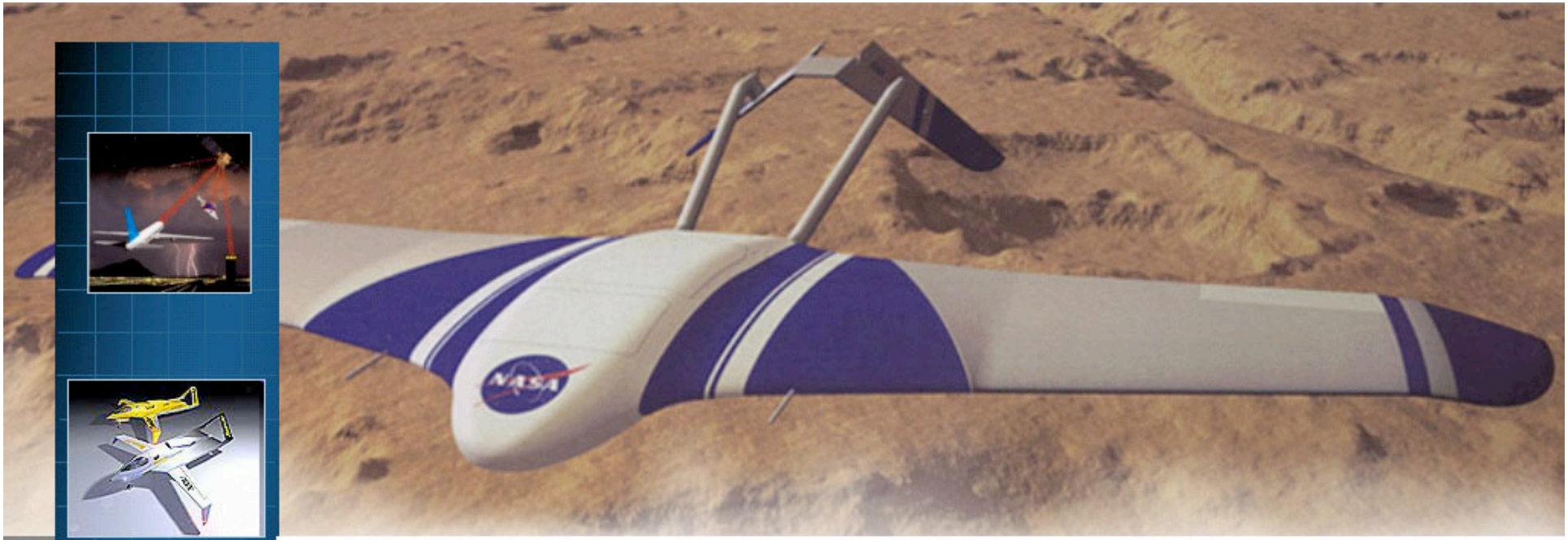


NASA AERONAUTICS enterprise

- Dr. J. Victor Lebacqz
- Associate Administrator

Suborbital Science Missions of the Future

April 9

Outline

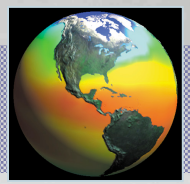
- **NASA Vision**
- Space Exploration Vision
- Aeronautics Exploration
- Aeronautics Programs

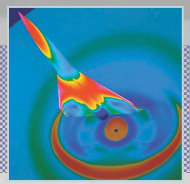
AERONAUTICS enterprise

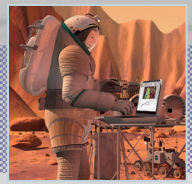
NASA's Vision & Mission

NASA'S Vision

- To improve life here
- To extend life to there
- To find life beyond



NASA's Mission

- To understand and protect our home planet
- To explore the universe and search for life
- To inspire the next generation of explorers

…as only NASA can

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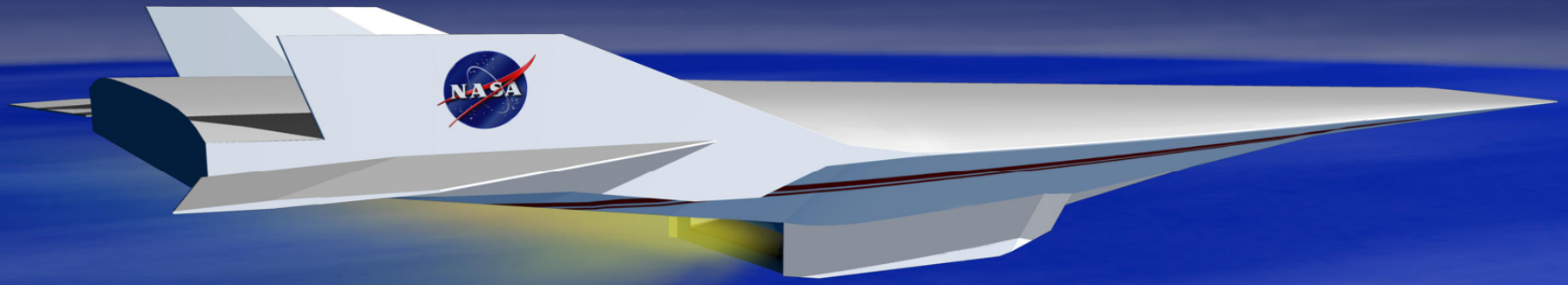
Aeronautics Exploration

To pioneer and validate high-payoff aeronautical technologies

To improve the quality of life
To enable exploration and discovery
To extend the benefits of our innovation throughout society.



Our success is measured by the extent to which our results are used by others to improve the quality of life and enable exploration and scientific knowledge

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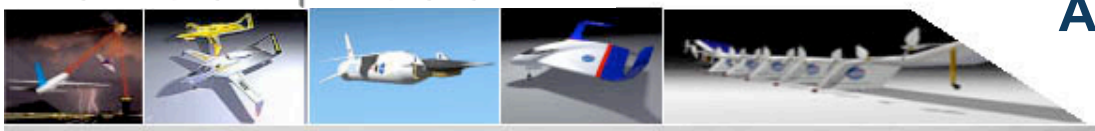


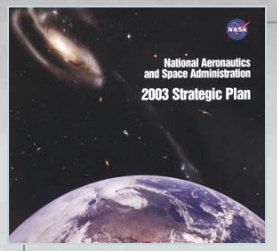
Aeronautics Enterprise Partners

The Aeronautics Enterprise Contributes to the NASA Vision and Mission through Technology Transfer and Application

NASA's Vision

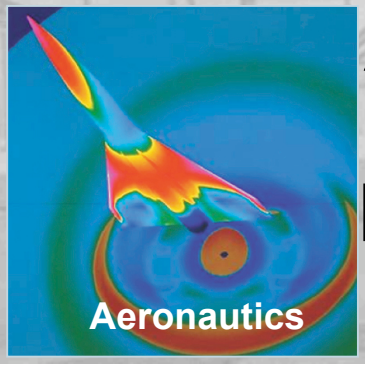
- To improve life here
- To extend life to there
- To find life beyond

Government Agency Partners



NASA's other Enterprises

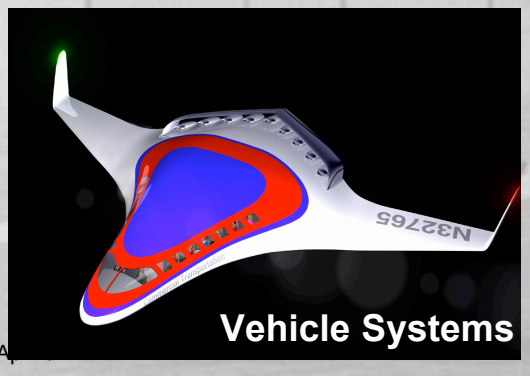
Universities

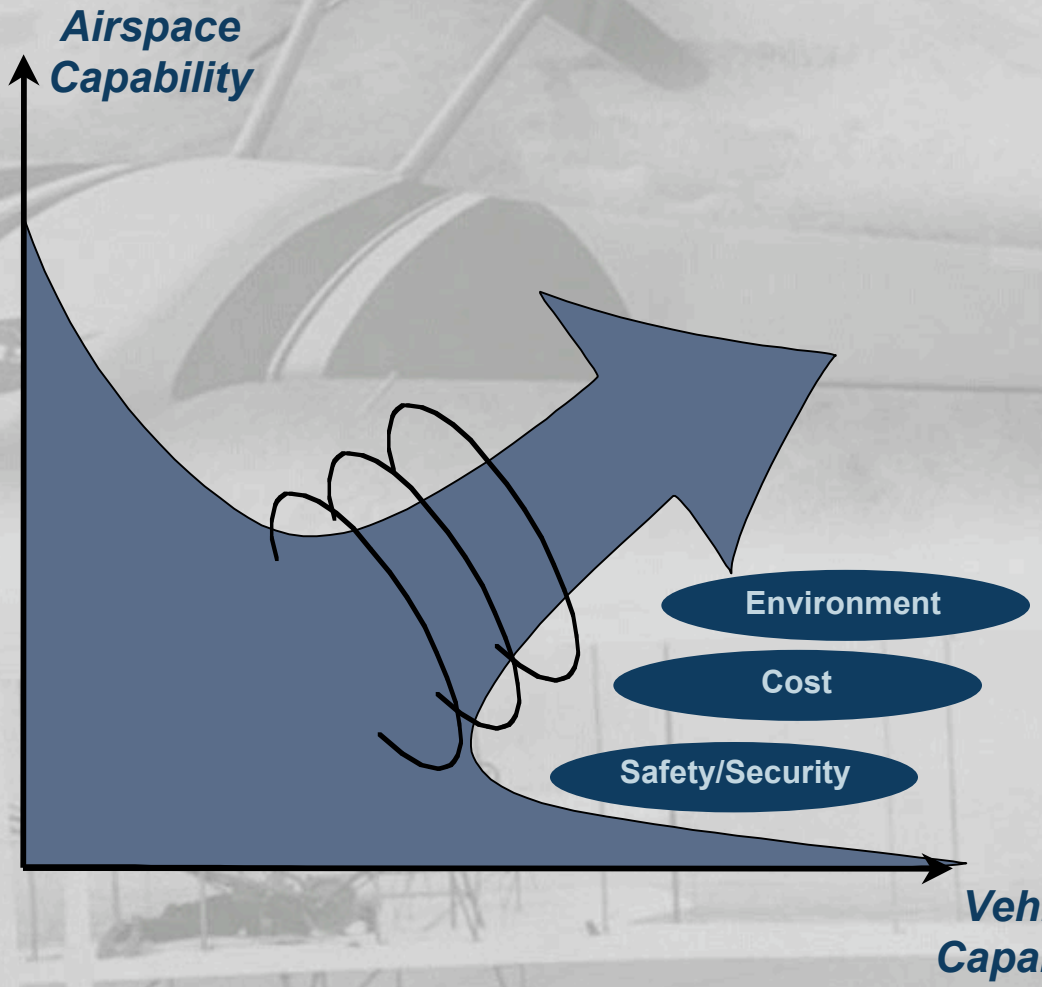


Industry

AERONAUTICS enterprise

Aeronautics Technology is Three Integrated Programs





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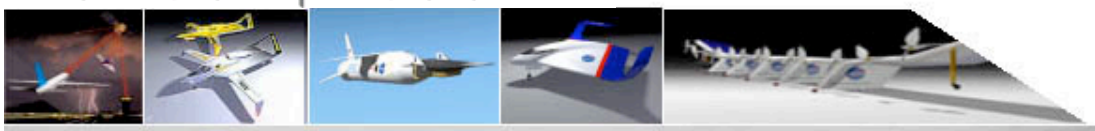
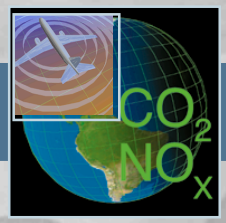


Aeronautics Technology Strategic Theme Objectives and Programs

Theme

Theme Objectives

Protect Air Travelers and the Public



Protect the Environment

Increase Mobility

Partnerships for National Security

Explore New Aeronautical Concepts

Programs

Aviation Safety & Security

Airspace Systems

Vehicle Systems

AERONAUTICS enterprise

Aeronautics Technology Program Matrix

Figure 3.1

■ Primary contribution to strategic objectives

● Supporting contribution to strategic objectives

NASA Goals and Objectives		Aeronautics Technology Programs: Aviation Safety & Security	Airspace Systems	Vehicle Systems
Goal 2: Enable a safer, more secure, efficient, and environmentally friendly air transportation system	Objective 2.1: Decrease the aircraft fatal accident rate, reduce the vulnerability of the air transportation system to hostile threats, and mitigate the consequences of accidents and hostile acts	■	●	●
	Objective 2.2: Protect local and global environmental quality by reducing aircraft noise and emissions		●	■
	Objective 2.3: Enable more people and goods to travel faster and farther, with fewer delays		■	■
Goal 3: Create a more secure world and improve the quality of life by investing in technologies and collaborating with other agencies, industries, and academia	Objective 3.1: Enhance the Nation's security through partnerships with DOD, DHS, and other U.S. or internationl government agencies	■	■	■
Goal 10: Enable revolutionary capabilities through new technologies	Objective 10.5: Create novel aeronautics concepts and technology to support science missions and terrestrial and space applications			■

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Office of Aeronautics FY2005 President's Budget

Aeronautics Technology	FY 04*	FY 05	FY 06	FY 07	FY 08	FY 09
Aviation Safety & Security	183.1	188.0	175.1	178.0	173.7	179.2
Vehicle Systems	621.5	576.8	606.4	576.2	575.3	582.9
Airspace Systems	232.3	154.4	175.2	183.6	176.7	179.8
AT Total	1,036.9	919.2	956.7	937.8	925.7	941.9

* FY04 includes Congressional Earmarks, rescissions, and proposed Congressional Operating Plan changes.

Six Programmatic Priorities

- Ensure NASA contribution to the air transportation system through the Joint Planning and Development Office (JPDO)
- Maintain emphasis on public goods research (Aviation Safety & Security, Noise & Emissions)
- Enhance or accelerate unmanned aerial vehicle (UAV) research
- Assess and leverage possibilities for supersonics
- Increase design and risk reduction activities for planetary aircraft
- Determine if there is a requirement to continue hypersonics research.

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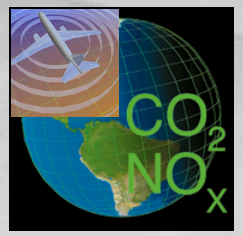
Aeronautics Technology Theme Objectives

FY 04 Strategic Plan — Near-Term Target Metrics

Protect Air Travelers and the Public

By 2005, enable a reduction of the aviation fatal accident rate by 50% from the FY 1991 - 1996 average



Protect the Environment

By 2007, enable a reduction in community noise due to aircraft by half, based on the 1997 state of the art

By 2007 enable a reduction of NOx emissions by 70 % from the 1996 ICAO standard and CO2 emissions by 25 % based on the 2000 state of the art

Increase Mobility

By 2004, enable a 35 % increase in aviation system throughput in the terminal area and a 20% increase in aviation system throughput based on 1997 National Airspace System capacities

Partnership for National Security

Transfer technology both to and from the DoD

Reduce the vulnerability of the air transportation system in partnership with DHS and TSA

Explore Revolutionary Aeronautical Concepts

By 2008, enable routine operations in the NAS above 18,000 feet for high-altitude, long endurance UAVs

Airspace Systems

Goal:

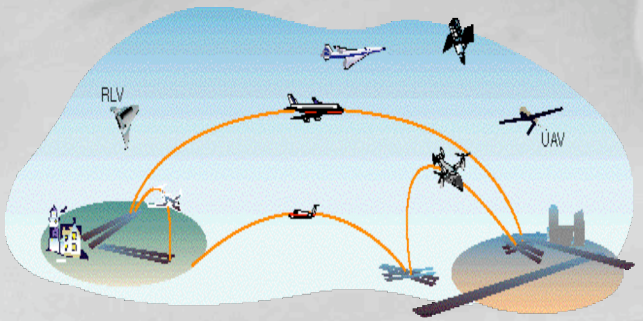
Enable major increases in the capacity and mobility of the air transportation system through development of transformational concepts for operations & vehicle systems

Objectives:

- Improve throughput, predictability, flexibility, collaboration, efficiency, and access of the NAS
  - Enable general aviation and runway-independent aircraft operations
- Maintain system safety, security and environmental protection
- Enable modeling and simulation of air transportation operations

Airspace Systems
Strategic Technical Focus Areas

Efficient Traffic Flow — Improving the efficiency of individual aircraft operating within the National Airspace System (NAS)



System - Wide Operations Technologies — Efficient operation of the NAS as an overall Nation-wide system with global interaction

Airspace Human Factors — Human interaction, performance and reliability in the design of complex airspace systems

Aviation Safety & Security Program

Goal:

Decrease the aircraft fatal accident rate and the vulnerability of the air transportation system to threats and mitigate the consequences of accidents and hostile acts

Objectives:

- Develop and demonstrate technologies that reduce aircraft accident rates and reduce aviation injuries and fatalities when accidents do occur
- Develop technologies that reduce the vulnerability of the National Airspace System to terrorist attacks while dramatically improving efficiency of security
- Transfer these advanced concepts, technologies and procedures through a partnership with the Federal Aviation Administration (FAA) and the Transportation Security Administration (TSA) in cooperation with the U.S. aeronautics industry

Aviation Safety & Security

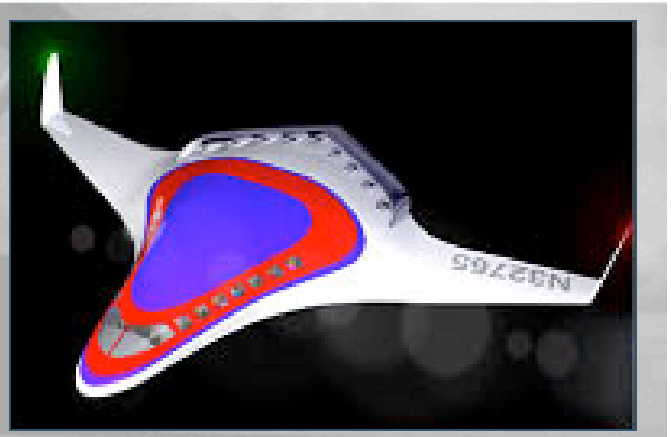
Strategic Technical Focus Areas

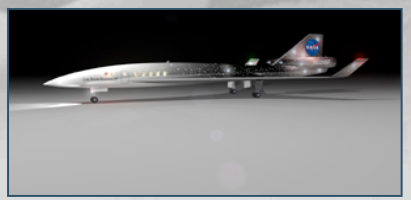
- **Aircraft Self-Protection & Preservation**
  - Protect and prevent damage to aircraft due to abnormal operations and system failures through advances in airborne-based technologies
- **Hostile Act Intervention & Protection**
  - Increase resiliency of the air traffic system against threats and hostile acts by providing technologies to identify and mitigate potential vulnerabilities
- **Human Error Avoidance & Mitigation**
  - Prevent unsafe flight situations due to breakdown between human and machine interface and promote optimal flight-crew performance, workload allocation, and situational awareness
- **Environmental Hazards Awareness & Mitigation**
  - Detect and/or eliminate the effects of natural hazards that could compromise safe ATS operation by reducing the role of atmospheric conditions in aviation fatal accidents, incidents, and injuries
- **System Vulnerability Discovery & Management**
  - Focus: Identify and inform users of potential ATS vulnerabilities by providing a system-wide safety-risk assessment capability that is accessible to and actively utilized by key stakeholders in the ATS

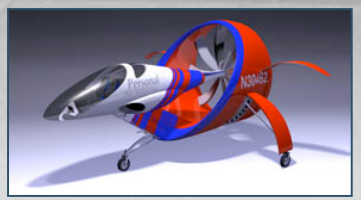
Vehicle Systems

Goal:

Enable key vehicle capabilities to fulfill the needs of the future air transportation system







Objectives:

- Reduce aviation noise by half: 10 db
- Reduce engine emissions: 70% NO_x & 25% CO_2
- Increase public mobility: more people to more places in less time
- Enable new aeronautical missions for Earth and planetary science
- Develop partnerships to leverage and enhance National aviation capabilities

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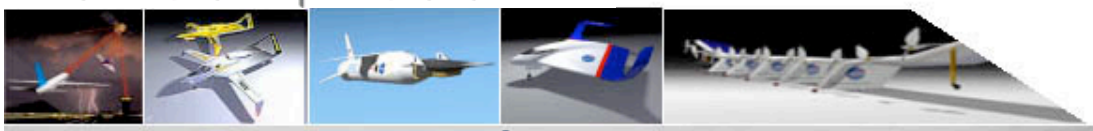
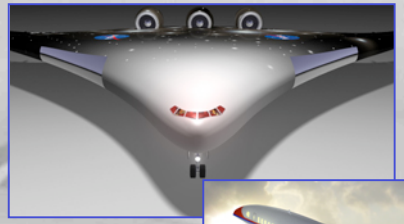


6 Vehicle Sectors



Subsonic Transports
Fay Collier & Bob Plencner

Supersonic Aircraft
Peter Coen & Mary Jo Long-Davis

Rotorcraft
Gloria Yamauchi

Uninhabited Air Vehicles
Larry Camacho

Personal Air Vehicles
Mark Moore

Extreme STOL
John Zuk

Associate Program Manager for VISTA
Bob McKinley
Teresa Kline

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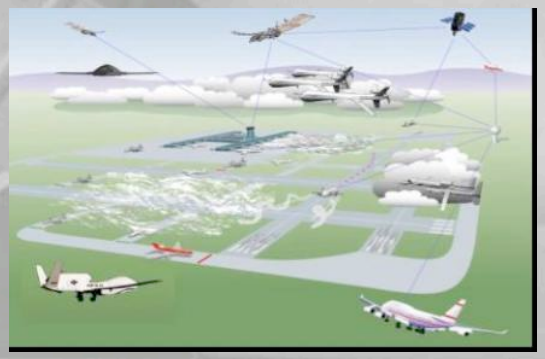
VSP Elements in HALE ROA:



Platform Capability

Altitude
Endurance
Payload
Range
Navigation

Mission Capability

Communications
Sensors
Integration
Multi-aircraft

Airspace Capability

Routine Access To NAS

	FY05	FY06	FY07	FY08	FY09	Total
HALE ROA in the NAS	$20.2	$21.6	$20.2	$20.2	$11.8	$94.0
HALE ROA Platform Capabilities	$17.6	$18.5	$17.6	$17.6	$11.7	$83.0
Earth Science Capability Demonstrations	**$12.7**	**$12.5**	**$12.5**	**$0.0**	**$0.0**	**$37.7**
F&SD HALE ROA Total	**$50.5**	**$52.6**	**$50.3**	**$37.8**	**$23.5**	**$214.7**
Sub-Orbital Science Tech Insertion	**$3.3**	**$3.3**	**$3.3**	**$3.3**	**$3.3**	**$16.5**
Sub-Orbital Science OPV	$9.5	$9.5	$9.5	$9.5	$9.5	$47.5

ESCD

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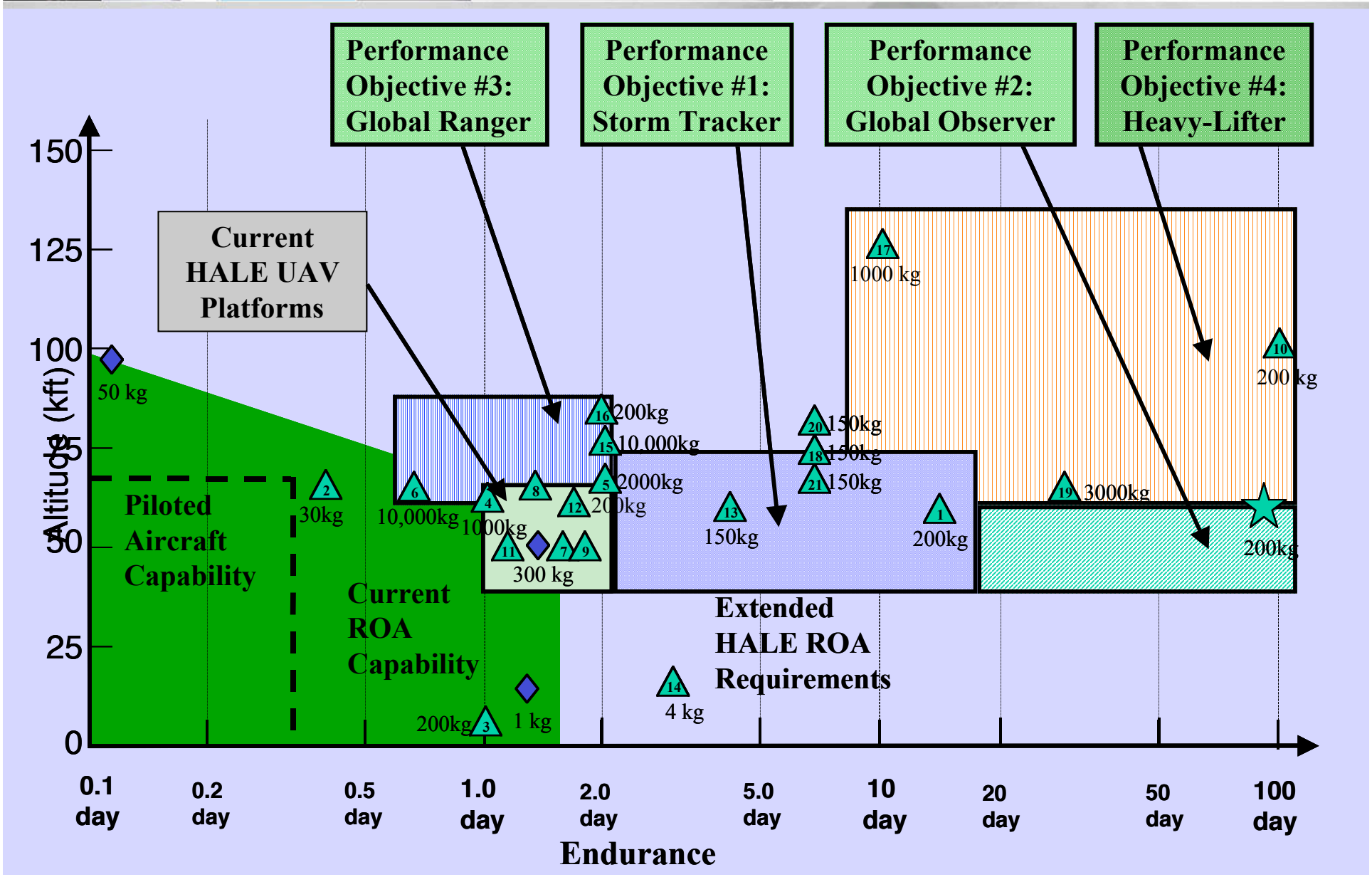
HALE ROA Science Platform Capabilities



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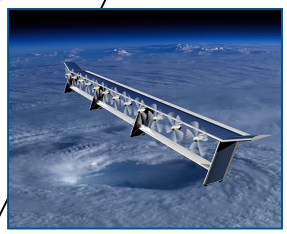
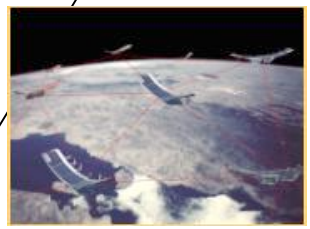
UAV Capability Development Timeline

Required Technologies @ TRL 6

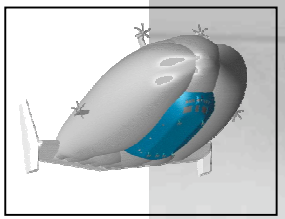
Current SOA:
- 60K ft @ 14 hrs - 200-lb
- 100K ft @ 1 hrs - 100-lb
- Pre-Programmed



HALE-ROA Capability Set
- 14 days @ 60-70K ft
- 400-lb Payload
- Autonomous Operations



10-Year Capability Set
- 100 days @ 75K ft
- 1000-lb Payload
- Autonomous Operations
- Collaborative Engagement

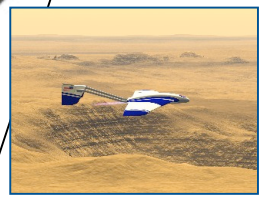


Full Capability Set
- Heavy Lift
- 100 days @ > 60K ft
- Autonomous Operations
- Collaborative Engagement

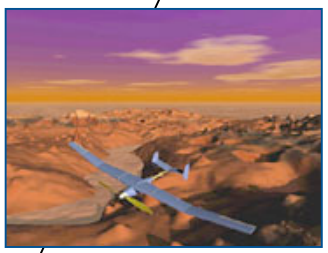
Current timeline FY09 FY14 FY19

PFV Capability Development Timeline

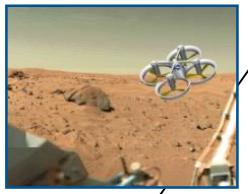
Required Technologies @ TRL 6

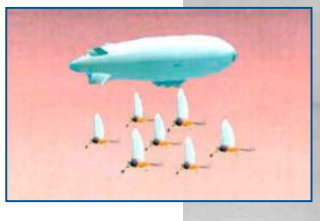


- Endurance: 1-2 hours
- Payload: 20-lb
- Pre-Programmed Flight Path



- Endurance: 8-10 hours
- Payload: 50-100-lb
- Feature targeting via terrain recognition





- Endurance: Multi-day
- Fully autonomous, sentient ops
- Surface interaction via deployed sensors and/or VTOL operations

Current timeline FY09 FY14 FY19

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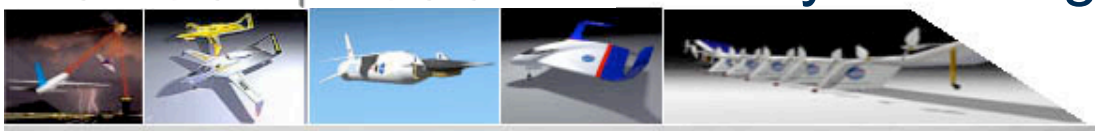
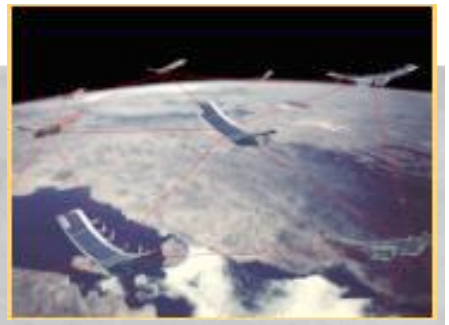
Key Enabling Technologies: HALE UAV's





- Intelligent Mission Management
  - SOA: Remotely piloted contingency management with lost-link waypoint navigation
  - Goal: Intelligent Decision Executive Architecture for autonomous, multi-ship, tactical group plan, resource allocation and contingency management for flight safety and mission assurance

- Intelligent System Software Verification and Validation
  - SOA: Module-level formal methods for deterministic software
  - Goal: Flight certified, auto-generated software V&V methods
- Endurance: Electric Propulsion
  - SOA: 10 kw solar array panels (= 18%); Regenerative Fuel Cells = 250 w*hr/kg @ 10 kw output
  - Goal: 20 kw thin film solar cells (> 12%);Solid Oxide Fuel Cells = 1200 w*hr/kg @ 10,000 kw;

- All Weather Launch, Deploy and Recovery Operations
  - SOA: High altitude operations and clear weather launch & recovery
  - Goal: All weather launch and recovery capabilities, and severe storm penetration and persistence, using intelligent anti-icing with electrical and hail hardened composite airframes

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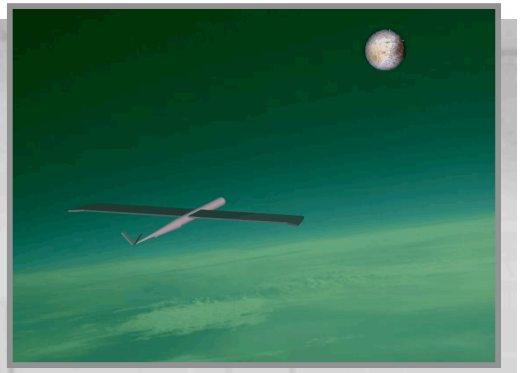
Key Enabling Technologies: Planetary Flight Vehicles

- Miniaturized UAV Flight Systems and Science Sensors
  - SOA: Discrete PC-104 class boards: FCC, INS, GPS, and Comm
  - Goal: Integrated single-board MEMS-class flight systems; embedded MEMS atmospheric chemistry sensors

- Aerodynamics:Efficient low Reynolds number airframes
  - SOA: Re > 1e6 with fixed-geometry wing loading > 1.0
  - Goal: Re <<0.5e6 with deployable wing and airframe components



- Precision Navigation and Landing Systems
  - SOA: Integrated Differential GPS/INS for Earth landing systems
  - Goal: Vision-based GN&C, precision landing and docking ports